Carotid Artery Occlusive Disease

Clinical Considerations in Surgical Revascularization

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■ *In clinical evaluation and analysis of 85 consecutive carotid endarterectomies in 74 consecutive patients, the operation was shown to be an effective and safe method of treating cerebral vascular insufficiency. It must be properly timed and performed, and excellent results may be expected, particularly in comparison with nonoperatively treated patients with the same disease.*

ONLY RECENTLY HAS there been a basis for comparison of operative and non-operative treatment of carotid artery occlusive disease at the bifurcation. The basis was supplied in a study by Shenkin and coworkers[6] of 30 nonsurgical patients, with diagnosis confirmed by arteriograms, who were observed for an average of two years. In 11 of them the condition was improved; in seven it was unchanged or worse; and 12 patients died as a result of stroke in the follow-up period. These results were discouraging in comparison with reports of surgical results in which mortality varied from 3 to 5 per cent.[3] Indeed, mortality has been reported as low as 1 to 2 per cent in patients operated upon for symptoms of transient cerebral ischemia or in whom the neurological deficit was stable.[2,7]

In the present study, mortality was within an acceptable range. Over all it was less than 5 per cent (four deaths in 85 cases); and when operations on patients with acute, frank stroke are excluded the mortality was 2.5 per cent. We have long since given up prompt operation in this latter group because of the obviously forbidding mortality of operating during acute stroke. Two of five patients with such operations in this series died, and this experience is similar to that of other investigators, who reported hemorrhage or massive edema into the freshly infarcted area occurring frequently.[4,5,8,9] In the present series one of each phenomenon occurred. Now a delay of at least a month before operation is the present rule in dealing with acute stroke.

It is of particular importance that the advantages of surgical treatment of carotid occlusive disease be reported since it offers 80 to 90 per cent good to excellent results, depending upon the series. This is in sharp contrast to the prognosis with nonsurgical treatment of this disease: 40 per cent of patients dead at two years and up to 80 per cent by the end of the fifth year. It should be added that the vast majority of these patients die of cerebral vascular insufficiency.

Since 60 to 85 per cent of the patients with an acute frank stroke will give a history indicative of previous transient cerebral vascular insufficiency, and since 50 per cent of those with transient ischemia will ultimately have a stroke, there can be no question that strokes are being prevented by revascularization during the transient phase of this disease.[1,7] Furthermore, investigators generally agree that only an extremely small number of patients will have further cerebral vascular insufficiency after revascularization, and in most cases when they do have insufficiency it is because

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they have an uncorrected lesion on the opposite side. The latter is often a factor when improvement postoperatively is less than satisfactory, thus stressing the need for an evaluation of both sides at the time of the examinations for revascularization are being carried out.

The clinical material consists of 85 consecutive carotid endarterectomy operations in 74 patients. All lesions were confirmed at operation after having been diagnosed clinically either by the presence of a bruit reaching a maximal point over the carotid bifurcation, or by angiography. In no case was there false positive diagnosis based on the presence of a bruit. Indeed, bruit was uniformly indicative of a high-grade lesion, although many such lesions did not produce a bruit. Angiography remains the main diagnostic tool (Figures 1 through 5). For the most part it is performed by the injection of contrast media into the aortic arch. In the present series a retrograde (transfemoral) approach to the arch was used in most cases. A transaxillary approach was used when peripheral atherosclerotic disease precluded the femoral approach. Because of the greater risk associated with direct carotid puncture, we used it only when neither of the other approaches was feasible. With correct positioning, pressure injection of sodium iothalamate (Conray®-400) into the aortic arch will visualize both extracranial carotid systems, usually simultaneously, with essentially no risk. Furthermore, since it causes only slight discomfort when local anesthesia is used, examination need not be hurried. Hydration beforehand prevents renal sequellae.

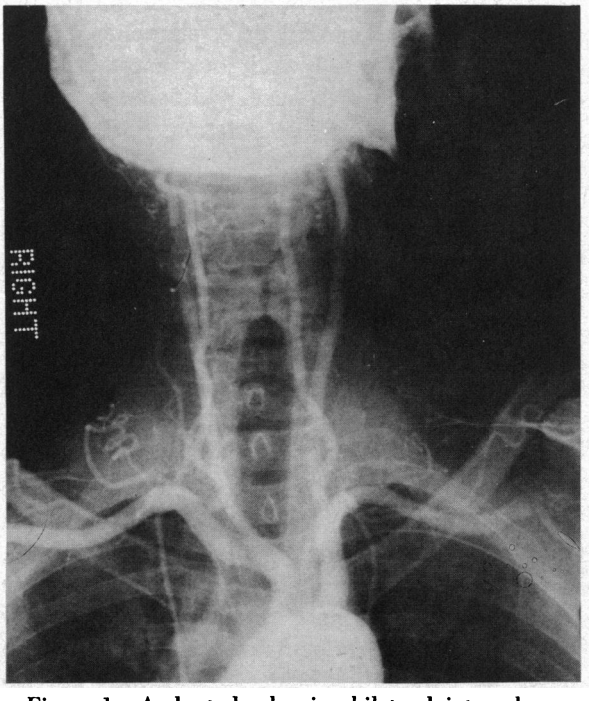

Figure 1.—Arch study showing bilateral internal carotid occlusive disease, and left vertebral artery stenosis at its origin.

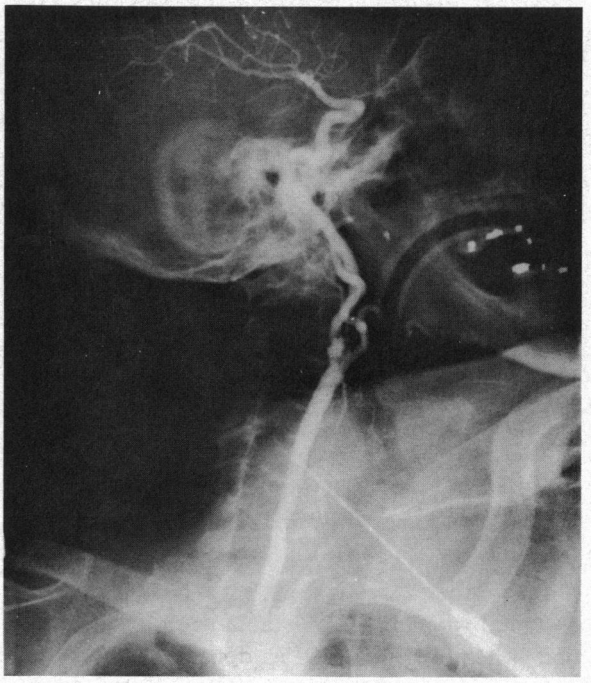

Figure 2.—Direct carotid puncture arteriogram showing severe stenosis at the carotid bifurcation, extending into the internal carotid artery. Arteriotomy had to be carried into the internal carotid artery, with subsequent patch grafting.

The clinical diagnosis was made by the presence of an audible bruit or angiographically visible defect with associated symptoms. In cases in which diagnosis was based on the presence of a bruit, if the patient did not improve as expected after operation, angiographic examination of the opposite side was carried out. This usually demonstrated the remaining lesion. Also when diagnosis was made by bruit and there was neurological defect on the side opposite the one which would be expected to be involved (so-called "paradoxical deficit") angiography was promptly carried out. In eight such patients the signs were found to be truly paradoxical, as was confirmed preoperatively by angiograms and by prompt resolution of symptoms after operation. From this it appears that patients with paradoxical signs have as good a prognosis for improvement by surgical operation as do patients in whom signs follow the expected pattern. In three patients paradoxical lesions were

suspected, diagnosed and treated successfully after the first operation did not bring about improvement. Eight other patients had similar lesions with orthodox signs, symptoms and resolution following operation, for a total incidence of 13 per cent in this series. Figure 1 is an angiogram made in one such case.

An unexpected finding was the reversibility of static neurological defects residual from stroke that had occurred as much as six years previously. In general, the longer the duration of such defects and the greater the severity, the slower the clinical improvement after operation. However, there were several striking exceptions. In two cases aphasia and hemiparesis of two and four years' duration abated rapidly, and in another case hemiplegia of two years' standing was almost completely resolved.

Like other investigators,[4] we have repeatedly observed worsening of a stable neurological situation when angiography is done too soon after stroke. Hence we withhold the procedure at this critical time lest it cause complete occlusion of the internal carotid.

Our mortality experience has improved considerably since we have been eschewing operation and even angiography of the aortic arch for at least a month and preferably longer after frank stroke. Mortality and morbidity have further declined since we began using hypothermia rather than shunts for the interim protection of patients who cannot tolerate a trial occlusion of the carotid bifurcation.

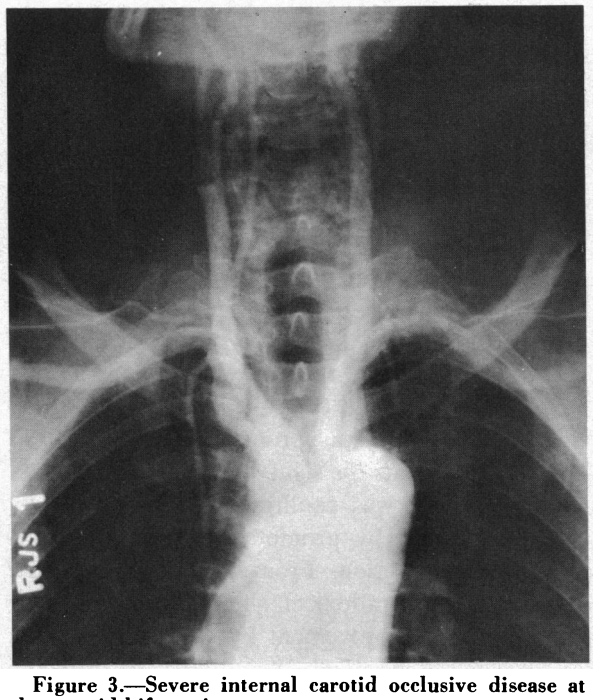

Figure 3.—Severe internal carotid occlusive disease at the carotid bifurcation.

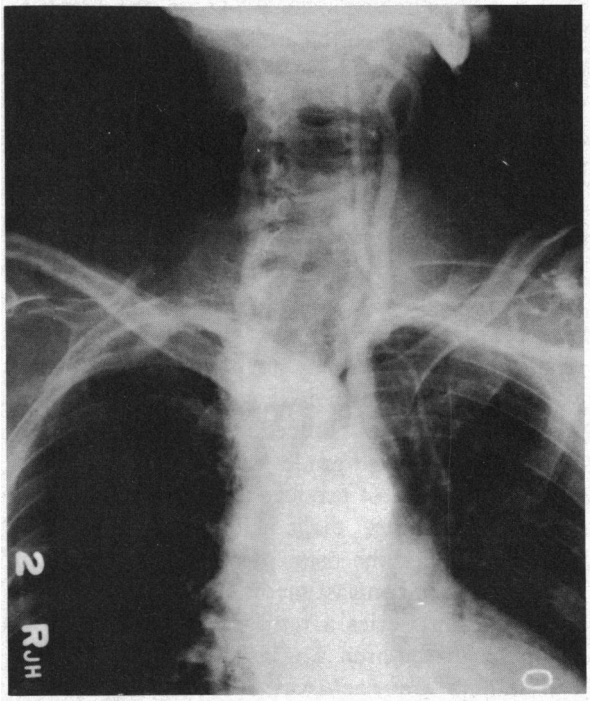

Figure 4.—Severe stenosis of the bifurcation of the left common carotid artery.

Operation to determine whether or not the patient can tolerate carotid cross-clamping can be done quite satisfactorily with local anesthesia and only 50 mg of hydroxyzine hydrochloride (Vistaril®) intramuscularly as sedation. Patients who cannot cooperate or are unwilling to do so (usually due to confusion secondary to cerebral vascular insufficiency) are operated upon under general anesthesia with hypothermia. Operation under local anesthesia has permitted extending the benefits to many patients in whom we would be reluctant to use deep anesthesia and hypothermia. For example, several patients in the ninth decade of life underwent operation and none required cerebral protection during cross-clamping.

At this point an important occurrence in one case in the present series should be mentioned: In that case occlusion of the common carotid, which up to this point had been the usual practice in determining tolerance to occlusion, was easily tolerated, the patient remaining alert and able to move all extremities, with no weakness of grip or of plantar flexion, for over five minutes of occlusion. However, when occluding clamps were

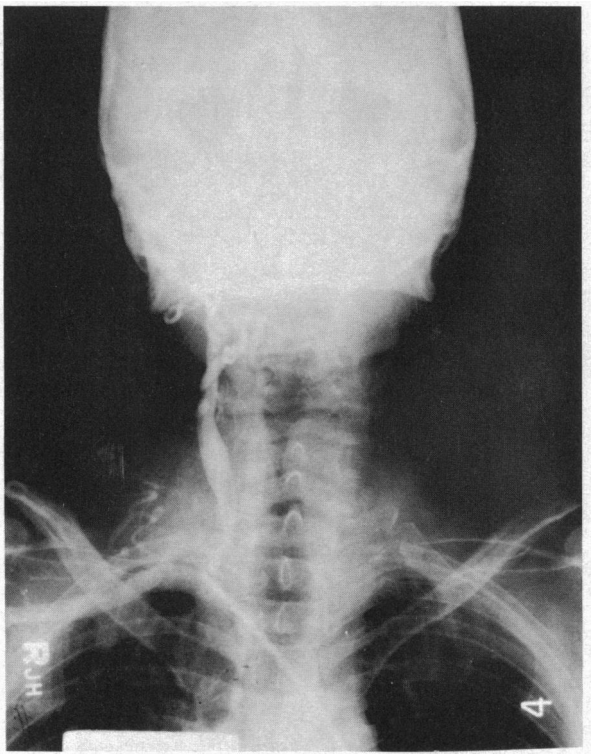

Figure 5.—Complete stenosis of the internal carotid artery with retrograde filling. Note catheter introduced into the innominate artery due to insufficient visualization on arch injection.

applied to the external and internal carotid as well as the common carotid, the patient promptly lapsed into unconsciousness and consciousness did not return on release of only the clamps on the internal and external carotid. Thus, it may be presumed that retrograde flow down the external and up the internal carotid was the protective mechanism. Occlusion of the common carotid by external pressure on the neck for whatever purpose, including priming of the patient for occlusion at operation, would be misleading in such cases.

Of primary concern when determining the ability of patients to withstand occlusion is the maintenance of adequate collateral diffusion through the circle of Willis by sustaining the systemic blood pressure at least at preoperative resting levels. The mean resting blood pressure for these patients was 160/90 mm of mercury and pressure was maintained at least at that level by the intravenous infusion of vasopressors during occlusion. Despite recent assertions to the contrary, we continue to give this measure prime consideration. We have often seen the level of consciousness or strength of grip deteriorate concurrent with a decrease in blood pressure, and then return to normal when hypotension is corrected by infusion of a vasopressor agent.

The operation is depicted in Figures 6 and 7. Arteriotomy is done in the carotid bulb only, thus avoiding the necessity of patch grafting. The procedure is after the method of Wylie and coworkers.[8] The occluding plaque almost invariably breaks off at normal intima distally. Since it is adherent there is no need to suture the distal intima. In only one case in this series did the disease extend for more than 1.5 cm up the internal carotid (Figure 2). In that case arteriotomy was extended into the internal carotid and patch grafting was carried out later. In view of this possibility, the arteriotomy should be angled toward the internal carotid.

The only other technical aspect not evident, and which facilitates the procedure, is ligation and division of the superior thyroid artery and the ascending pharyngeal artery. The latter, in particular, may not be evident and causes annoying back-bleeding during dissection as it commonly arises from the very bifurcation itself. Infiltration of this area before dissection is important, as the carotid body lies in this location and reflex hypotension may follow manipulation of it.

The only consistent morbidity in this series was headache, usually beginning two to three hours after operation and lasting 36 to 72 hours, then rapid abatement with no treatment except analgesia. It is due no doubt to transient cerebral edema, resulting from the brief period of ischemia at the time of cross-clamping during operation. Occlusion lasted only an average of slightly over seven minutes. Recently the problem has been almost completely averted by parenteral administration of 16 mg of dexamethazone, half of it before operation and half after.

Comment

Of great clinical importance is the fact that vertebral lesions were found to be invariably associated with carotid bifurcation lesions and any vertebral-basilar symptoms were uniformly corrected by carotid endarterectomy. Furthermore, vertebral-basilar symptoms were among the most common, vertigo being the most frequently noted. It responded well to carotid endarterectomy. Contrary to clinical impression in the past, only 40 per cent of the patients with transient cerebral vascular insufficiency proved to have correctible intracranial carotid occlusive disease when investigated by arteriography.

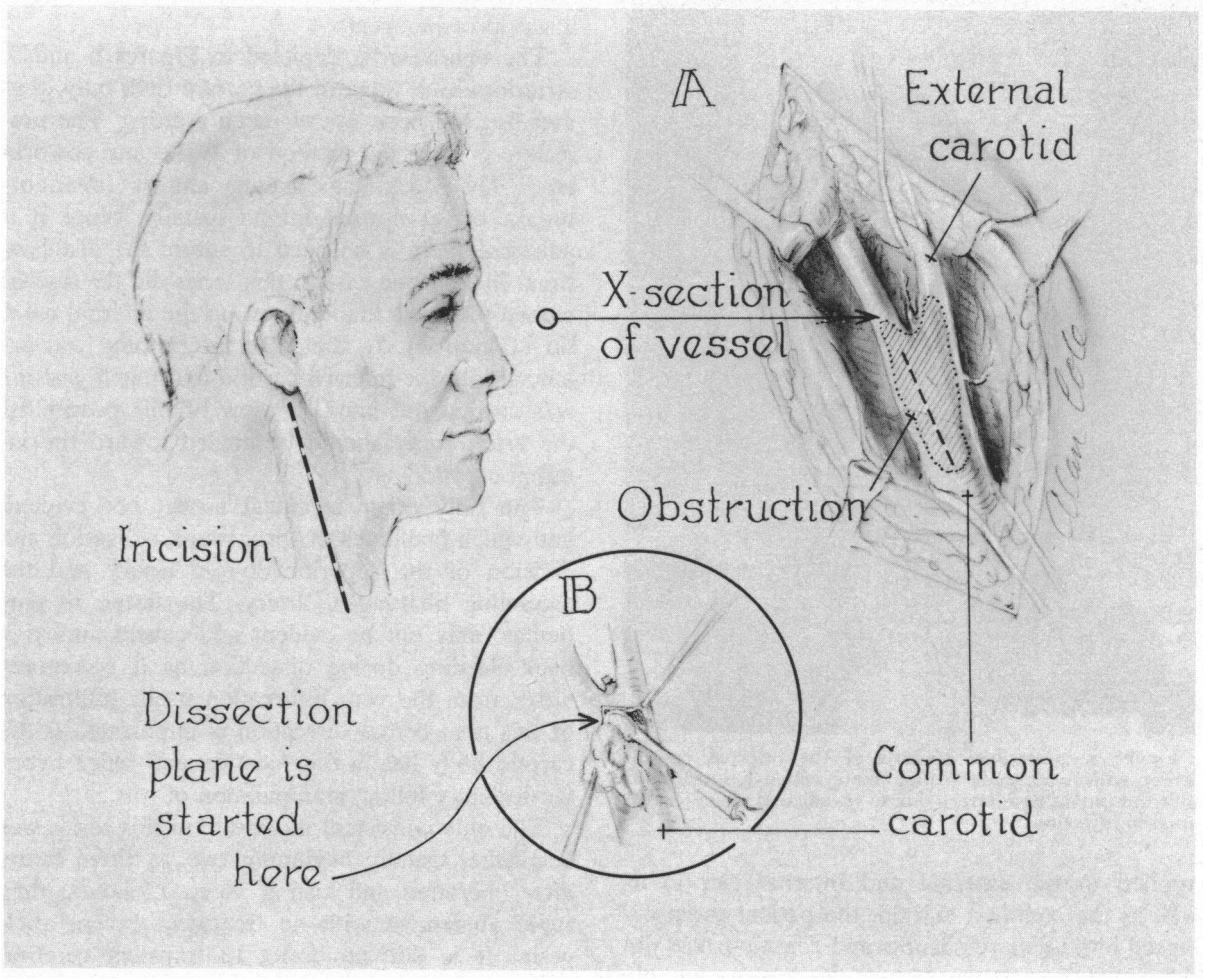

Figure 6.—A—Arteriotomy in the carotid bulb angled toward the internal carotid artery. The shaded area illustrates the usual configuration of the occluding lesion. B—Note the ascending pharyngeal artery ligated. Subintimal dissection is begun.

After vertigo, the next most common symptom was episodic syncope, the episodes becoming more frequent as time passed. Ataxia and hemiparesis were the next most common, followed by aphasia and defects in cerebration. Tinnitus due to the hemodynamic effect of the stenotic arterial lesion *per se,* was very common. It always abated upon removal of the clamps after endarterectomy.

It is pertinent that we consider here four patients, in whom the diagnosis of occlusive disease at the carotid bifurcation was proved by arteriogram, and who refused operation. Closely controlled anticoagulation was chosen as an alternate method of treatment by each patient's private physician. In all cases the symptoms which the patients had when first observed—namely, syncope and hemiparesis in two and vertigo in two—continued or recurred. The intensity and frequency of symptoms rapidly progressed in all patients. Acute frank stroke, manifested by complete hemiplegia and aphasia, occurred in one patient eight months from the time diagnosis was made and treatment begun. All patients requested operation sooner or later after the time of diagnosis—the interval varying from nine to twelve months. In contrast to anticoagulant therapy, carotid endarterectomy relieved symptoms completely in three patients and resulted in pronounced improvement in the patient with hemiplegia and aphasia.

One patient described a growing intensity of tinnitus due to hemodynamic defect which was evidenced by an increasingly audible bruit. Thus it is evident that anticoagulants in no way influenced the course of this disease in this group of carefully controlled patients. All patients were seen three times weekly, and the prothrombin con-

centration at no time was permitted to rise to more than 20 per cent of normal. A fifth patient in this group, in whom diagnosis was confirmed, died of acute post-traumatic subdural hematoma. Prothrombin time was 10 per cent of normal in this patient at the time of admission one hour after trauma.

Another interesting phenomenon encountered in this series is the concurrence of arterial hypertension with carotid occlusive disease. Eighty-five per cent of the patients had diastolic blood pressure of over 110 mm of mercury when first observed. By the time they arrived at the operating room, after a period of sedation, bed rest and premedication with intramuscular hydroxyzine hydrochloride (Vistaril®), the mean diastolic pressure had been reduced to 90 mm of mercury. The systolic mean dropped from 200 on admission to a range of between 150 and 160 mm. In 90 per cent of these patients, the mean diastolic pressure stabilized in a range between 70 and 80 mm postoperatively. It is postulated that the gradient proximal to the carotid sinus led to this increase in arterial pressure. In four patients, with otherwise nearly complete relief of symptoms, the pressure did not change until the lesion on the opposite side was corrected.

Our high mortality rate associated with revascularization after acute strokes—two of five patients died—was similar to rates reported by Wylie[8,9] (42 per cent), by Perdue[4] (33.3 per cent) and by Robinson[5] (21 per cent).

Our series of patients may be roughly divided into two groups, half having had completed stroke presenting with varying degrees of chronic cerebral ischemia, and half having symptoms of transient cerebral ischemia. The results were equally good in both groups—almost 90 per cent of the

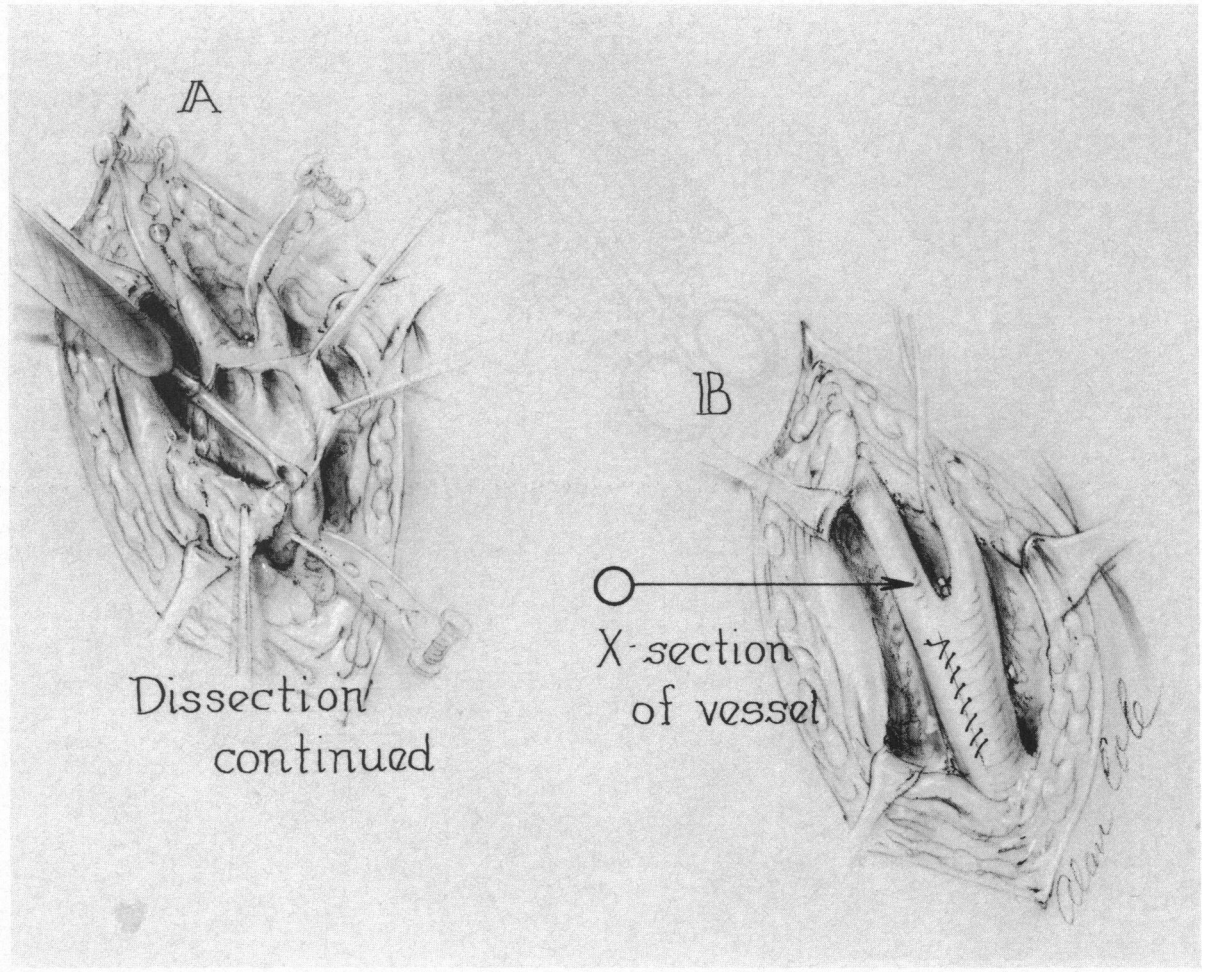

Figure 7.—A—Subintimal dissection completed. B—Closure of arteriotomy without stenosis.

patients having resolution of the chief deficit or symptom complex. These statistics compare favorably with those reported by other investigators.

Generic and Trade Names of Drugs

Sodium iothalamate—*Conray*®-400
Hydroxyzine hydrochloride—*Vistaril*®

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